Isotopic Characterization of Rainwater and Air Moisture at Roorkee

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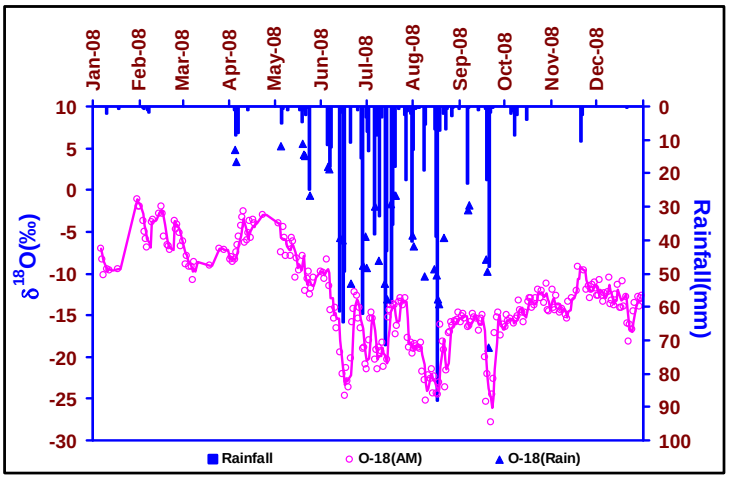
Water is essential for all forms of life and is a fundamental resource for socio-economic developments. India receives its rains mainly from the southwest (SW) monsoon and it has direct impact on India's agriculture produce which constitutes quarter of the GDP and 60% of its total workforce. Delayed rains or weak monsoon not only derail the onset of Kharif crop but also cause problems in hydro-power generation, reduced surface water sources resulting in reduced groundwater recharge leading to drying up of hand-pumps and open-wells. Monsoon brings copious amount of rains from the influx of moist winds from the adjoining seas (Arabian Sea & Bay of Bengal) and Indian Ocean to the sub-continent. After the end of monsoon, moisture flux gradually decreases but remains to some residual level due to constant input from local moisture associated with evaporation of moist surface soils, surface water bodies and evapo-transpiration. Other than local and SW monsoon, moisture influx also comes through Western Disturbances (WD) especially in the north-west parts of India and through north-east (NE) monsoon mainly in the south-east part of India. It is not possible to distinguish the sources of vapor through ground-based meteorological parameters (humidity, temperature etc.) or through chemical analysis of water vapor, as whether originating from SW/NE monsoon, local vapor or due to WD. However as these vapors have differences in their relative isotopic composition ($^{1}H^{1}H^{16}O$, $^{1}H^{2}H^{16}O$ and $^{1}H^{1}H^{18}O$), therefore, isotopic composition of vapors can be used to distinguish and indentify their source and timings of their arrival and departure at the site of observation. Since vapors and rains have associated features, therefore a proportionate change is expected in their isotopic composition whenever source of their origin changes. The advantage of monitoring vapor over rain is due to its all-time availability in space. The reliability of isotopic technique for needs verification of whether isotopic variation in rains and associated vapor changes uniformly with change in the source of origin of moisture. In the present paper, isotopic technique in meteorological science has been examined through ground-based data analysis at Roorkee, Uttarakhand, India. The site receives rains mainly from SW monsoon and few showers from WD. Total 35 rains and 261 water-vapor samples were collected to characterize rains and associated water-vapor for the year 2008. Isotopic analysis was carried out using Isotope Ratio Mass Spectrometer and the data was expressed in the units of $\delta^{2}H$ & $\delta^{18}O$. The time series spectrum of the observed isotopic data ($\delta^{18}O$) on rains and air-moisture is shown in the fig. 1, which clearly indicates seasonal changes in isotopic pattern with a valley feature during the



monsoon. This clearly depicts isotopic features in resolving local vapor from monsoon vapors. The influx of moisture during non-monsoon period also imprints in the isotopic record as minor valleys in local background. Through isotopic systematic, the paper introduces isotopes as a new parameter to understand Indian meteorology.

Figure. 1. Variation in $\delta^{18}O$ in Rainfall and Atmospheric Air-Moisture and the Rainfall Amount